

The Evolution of Gridded NUCAPS: Transition of Research to Operations

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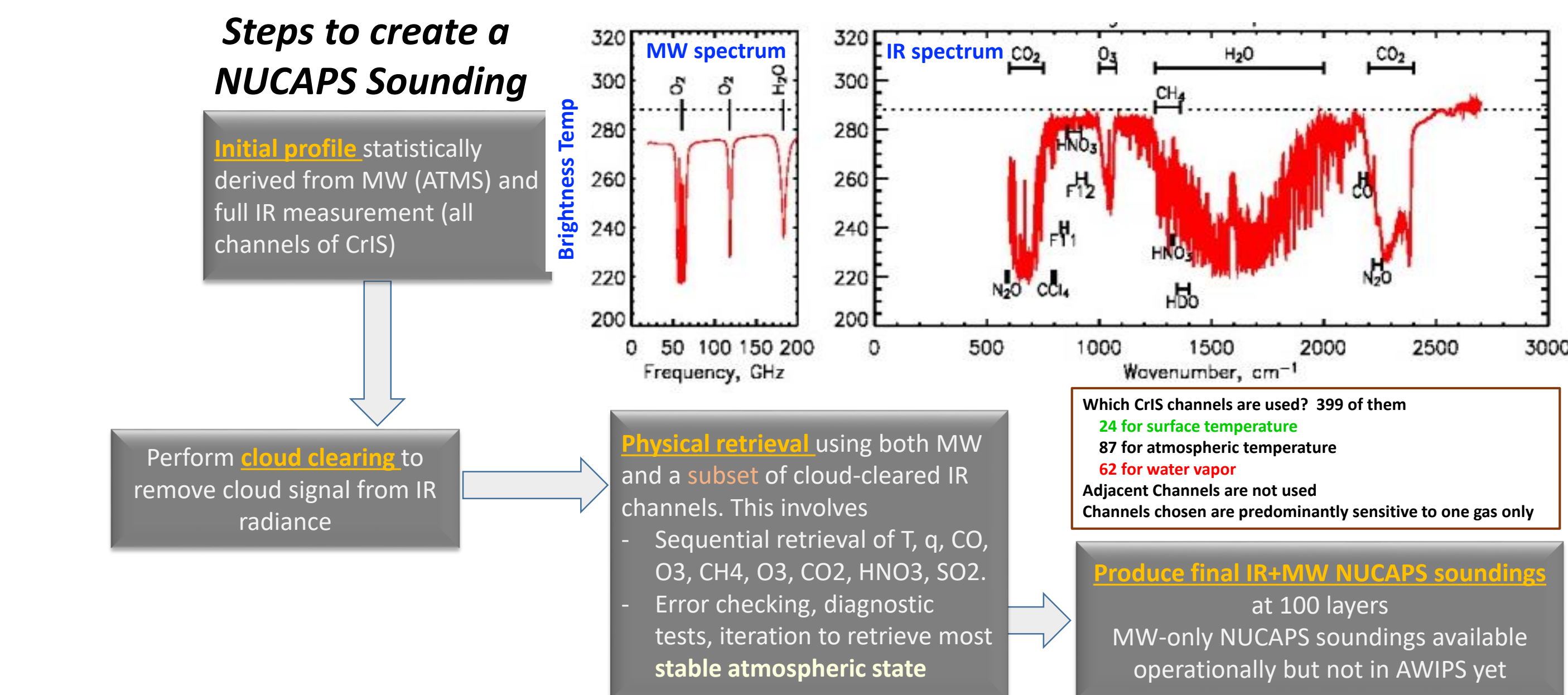
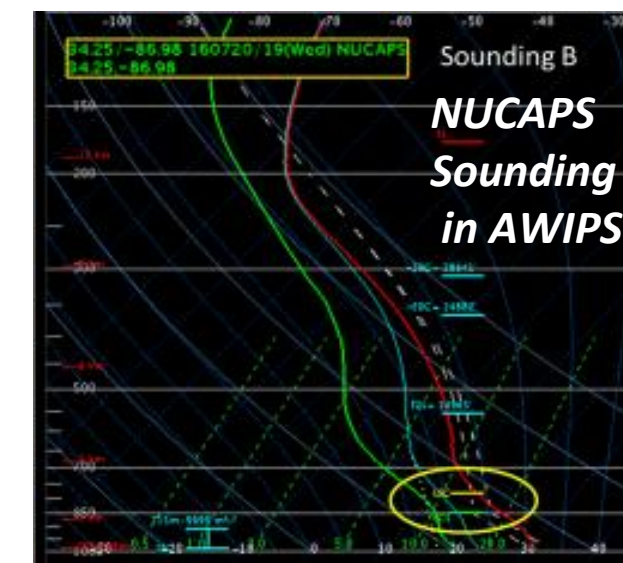
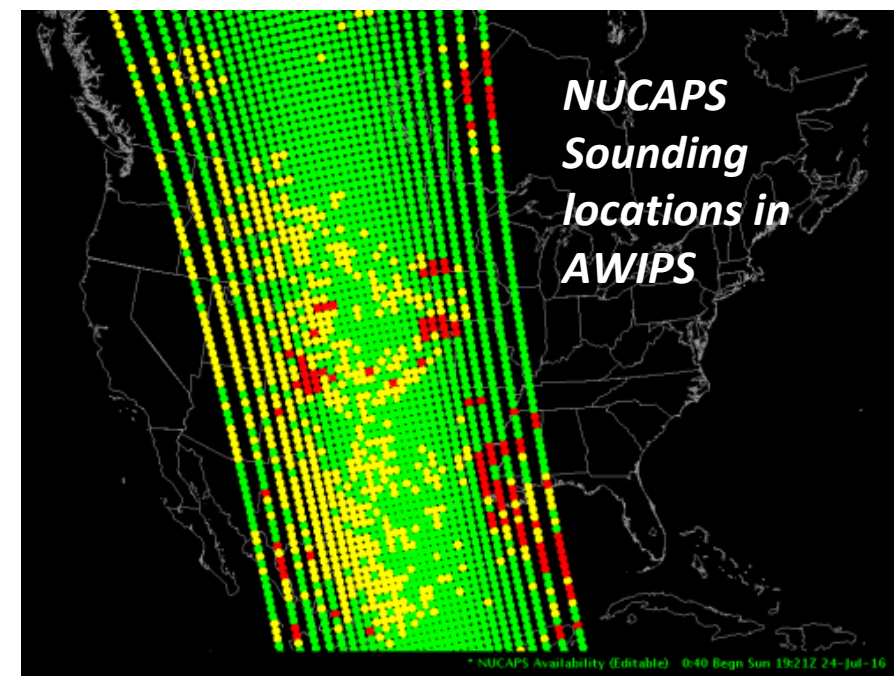
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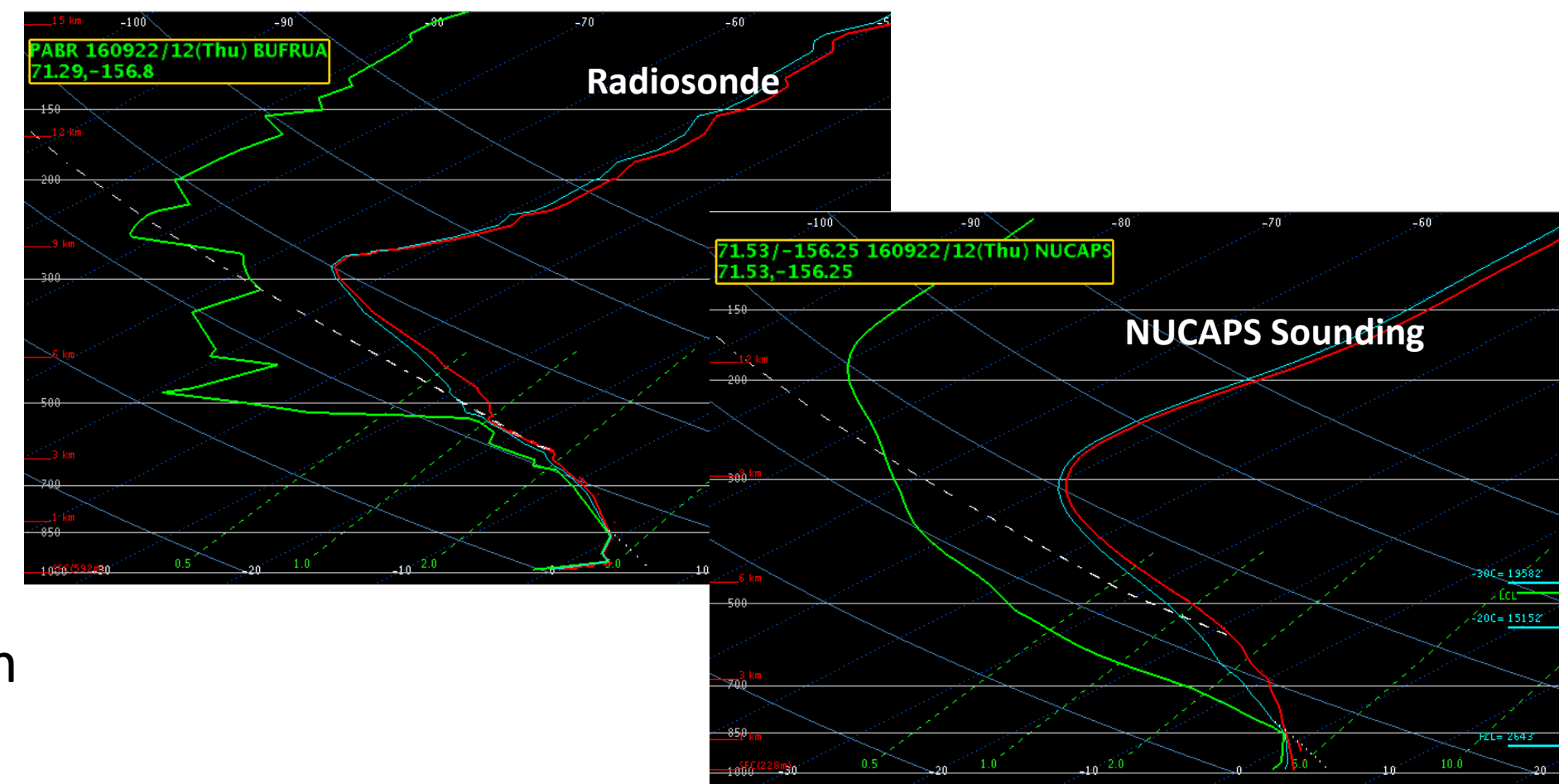


Introduction

- The next-generation S-NPP and NOAA-20 Cross-track Infrared Sounder (CrIS) temperature and moisture profiles can provide valuable observations
 - Where conventional radiosonde observations are sparse
 - Between radiosonde launches
- CrIS Infrared (IR) observations are combined with the Advanced Technology Microwave Sounder (ATMS) Microwave (MW) observations to produce high quality vertical soundings in clear and partly cloudy conditions
- NUCAPS (NOAA Unique Combined Atmospheric Processing System) is the operational algorithm for processing combined hyperspectral IR sounder and MW sounder measurements
- NUCAPS Soundings are operationally available in AWIPS as Skew-T plots
- The capability to visualize the data in plan view or cross section would be valuable to maximize the benefits of NUCAPS data in AWIPS
- A multi-organizational collaboration through the JPSS Sounding Applications Initiative developed an experimental capability for plan view and cross section displays of NUCAPS Soundings observations in AWIPS (i.e., Gridded NUCAPS)
- Gridded NUCAPS is newly available in AWIPS 19.2.1-29

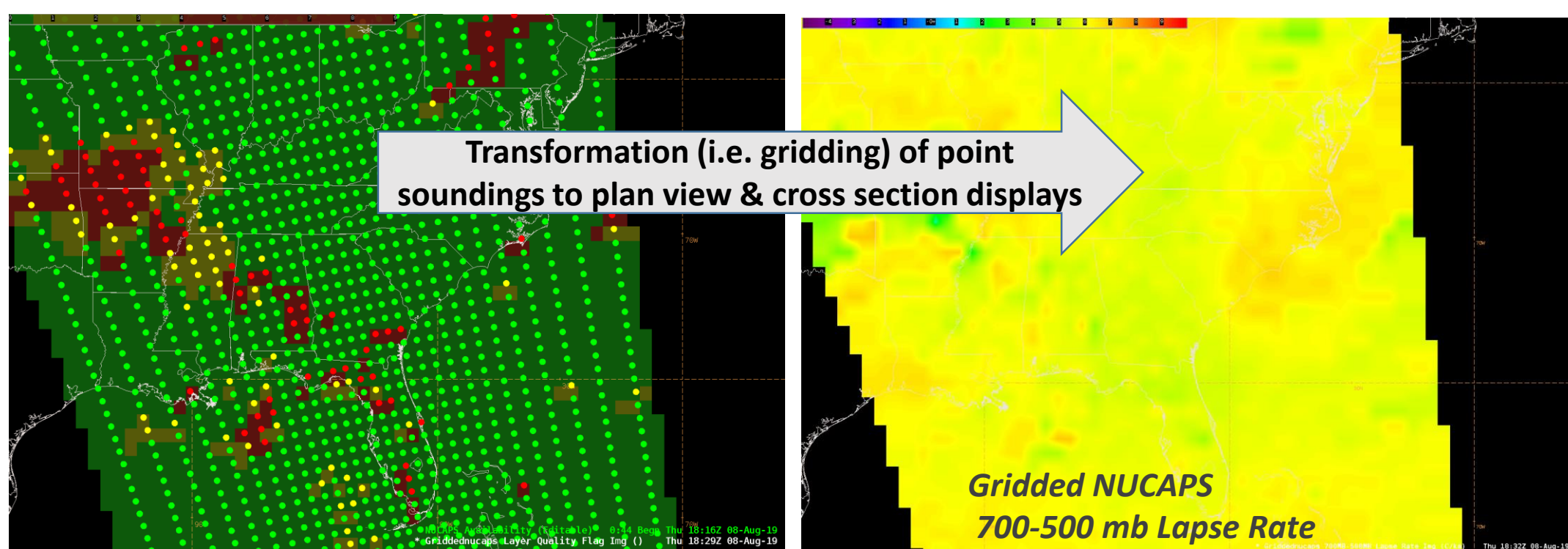


- NUCAPS retrieves temperature and moisture information as **thick layers stacked together to form a vertical atmospheric column** from surface to TOA
- How are the layers vertically distributed?
 - it varies slightly from scene to scene and is dependent on Earth surface temperature as well as local weather conditions
 - So what does this mean in operations?
 - compared to radiosondes, NUCAPS has a smoother appearance
 - compared to GOES soundings, NUCAPS has high vertical definition



NUCAPS Soundings: Need to click on each 'point' to review the vertical information

- Pros:* Can choose specific locations
- Cons:* A lot of individual interrogation



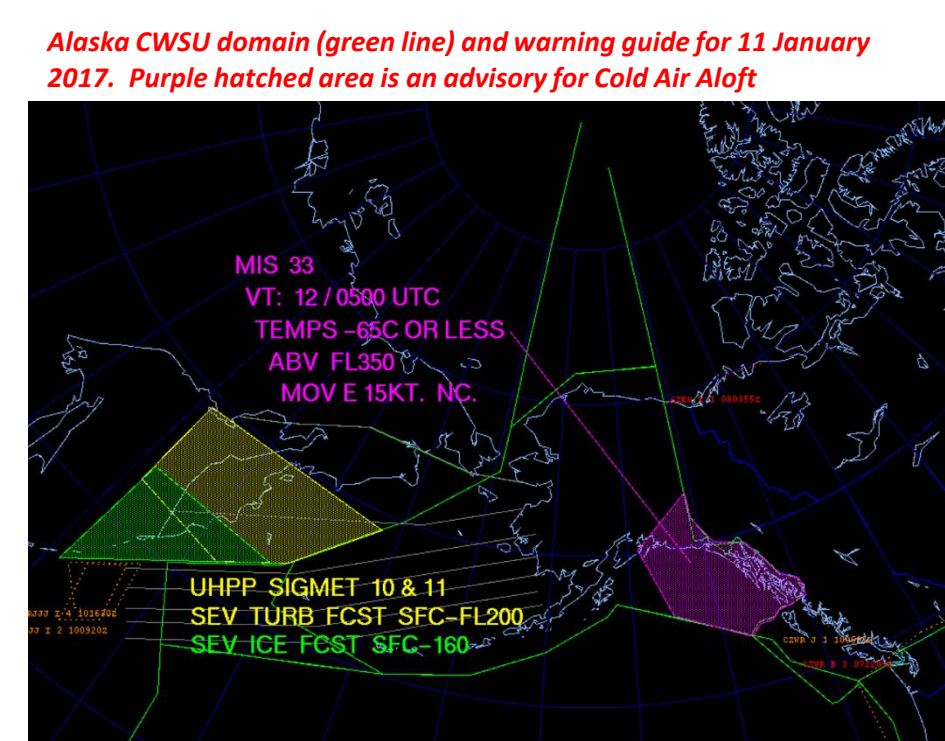
More Information: <https://vlab.ncep.noaa.gov/web/nasa-sport/gridded-ncaps>

Gridded NUCAPS: Ingested into AWIPS on a uniform grid 0.5 degree lat/lon grid

- Minimal horizontal interpolation, vertical interpolation to standard levels
- Temperature, moisture, and derived fields such as precipitable water, Haines Index, and ozone fields
- Can display single level or layer products

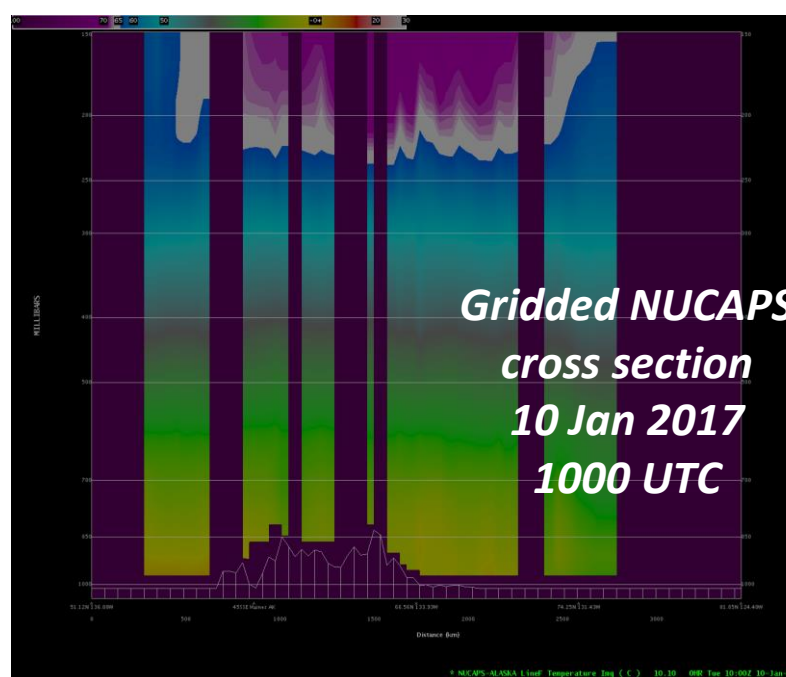
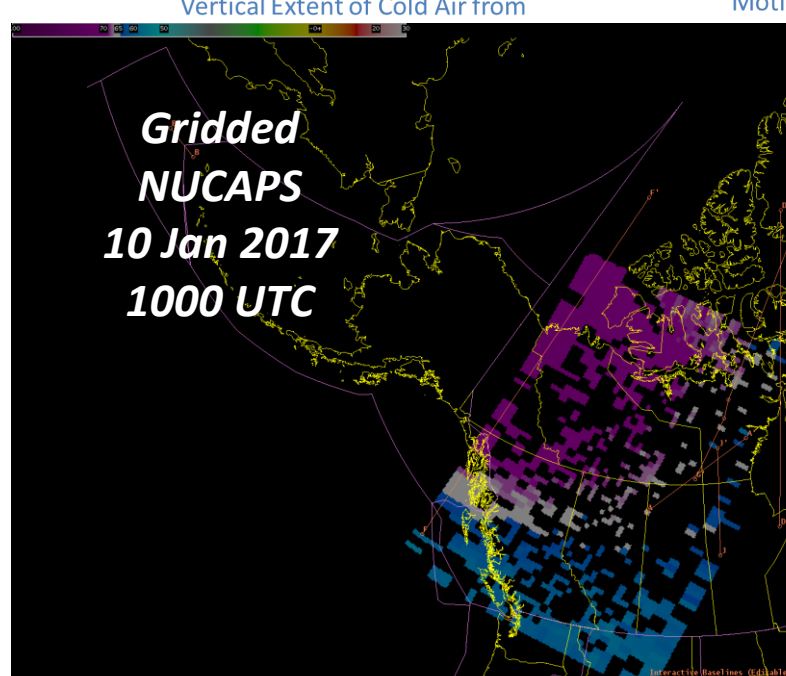
Cold Air Aloft

- Gridded NUCAPS was initially developed to address Cold Air Aloft (CAA)
- Cold Air Aloft ($\leq -65^{\circ}\text{C}$) events can freeze jet fuel and regularly occur at flight levels in the Arctic
- The Anchorage Center Weather Service Unit (CWSU) provides Meteorological Impact Statements (MIS) to Air Traffic Controllers to direct flights around the 3D air features
- In data sparse Alaska, forecasters have relied on analysis of model fields and limited radiosonde observations to guess the 3D extent of the Cold Air Aloft
- Use of satellite observations provides an opportunity for forecasters to observe the 3D extent of the Cold Air Aloft in real-time
- Forecasters at the Anchorage CWSU evaluated the Gridded NUCAPS during the 2016-2017 & 2017-2018 Winter
- Goal was to provide data to improve Cold Air Aloft analysis and increase confidence when issuing operational MIS statements used by the FAA and airlines.
- After two evaluations forecasters have integrated NUCAPS into their forecast process for Cold Air Aloft



Example text product disseminated by Alaska CWSU for Cold Air Aloft, valid 14 November 2015

FAKXZ0 KXAN 121458
ZAN MES 01 VALID 121500-130300
... FOR ATC PLANNING PURPOSES ONLY ...
COLD AIR ALOFT?
FROM 150NM SCD+45NM DRT-350W DNM-113NM DNM-18NM SCD
TEMPER -45C ON J25E EN FL350-400. AREA MOVG NE @ 10 KTS.
CHW NOV 14

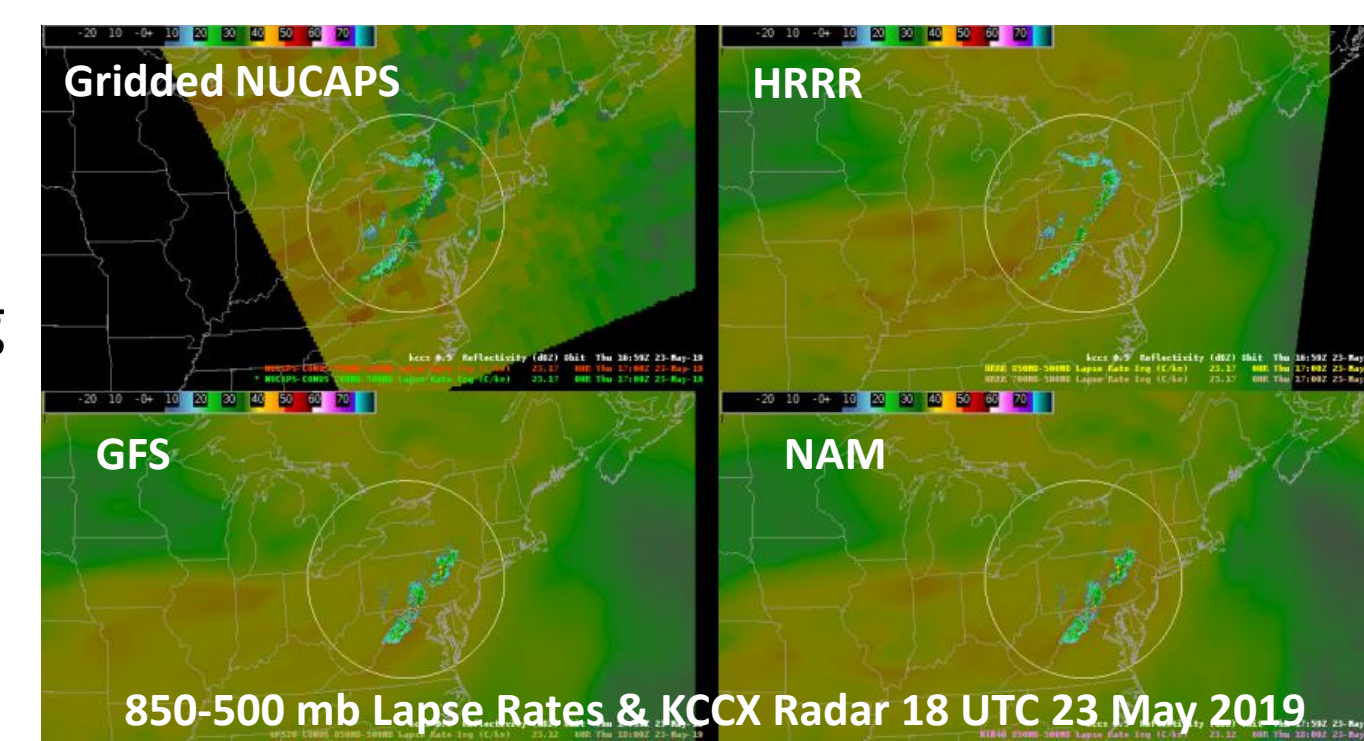


"Gridded NUCAPS data and soundings were in excellent agreement this morning with CAA over much of the state." [sic] -CW

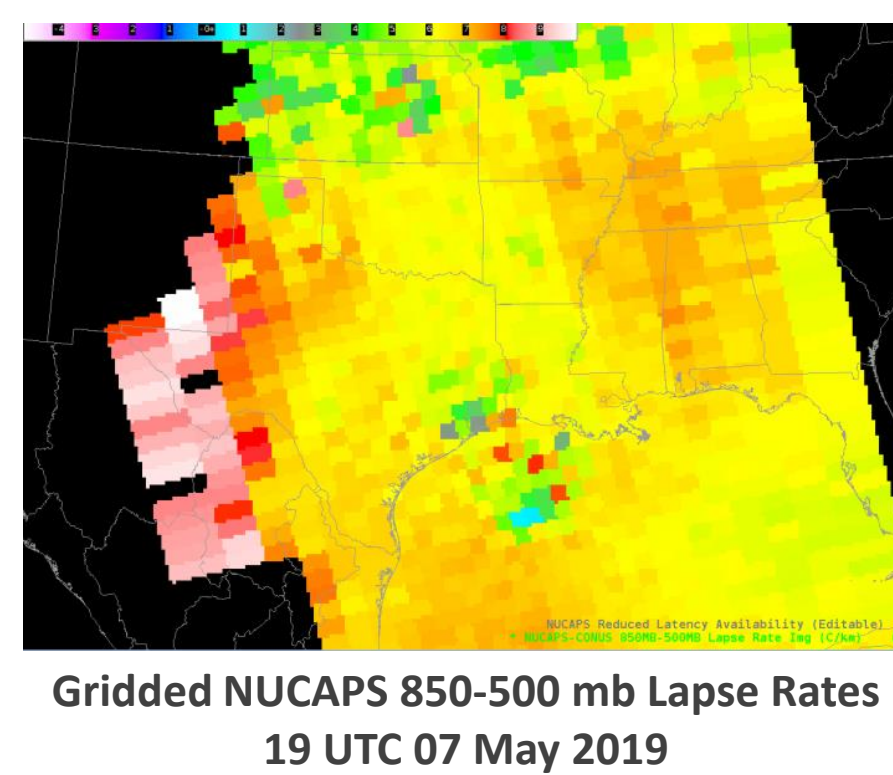
"NUCAPS trends matched NWP trends of the CAA area moving to the southeast over the Panhandle and out of our airspace by 23/06Z." [sic] -GW

Pre-Convective Environment

- Gridded NUCAPS was first demonstrated at the Hazardous Weather Testbed in 2016, while point Soundings were first demonstrated in 2015
- The goal was to test the utility of Gridded NUCAPS for analyzing the pre-convective environment
- The advantages of the Soundings are:
 - Observations between radiosonde launches
 - A dense network of observations over a 2,200 km swath
- Testing at HWT solidified the value of Gridded NUCAPS:
 - To assess thermodynamic spatial gradients/patterns
 - As another observation tool to increase situational awareness
- Forecaster feedback led to product improvements and best practices
 - View the data on standard pressure levels
 - Leverage AWIPS derived parameters
 - The value of spatial gradients in mid-level fields
 - AWIPS procedures and recommended fields to analyze
 - Best practices to address data quality and gaps

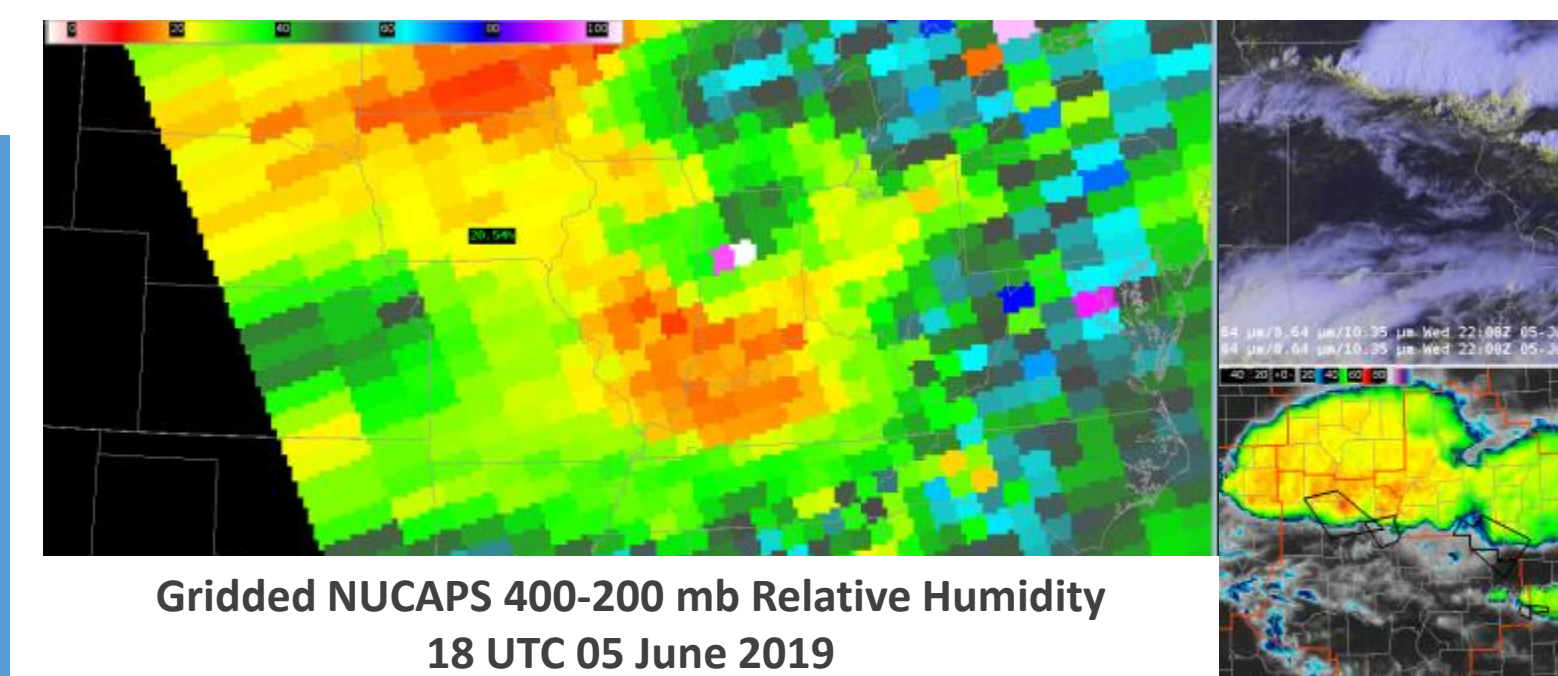


...it's clear why this area [SW to NE from central W VA to New England] had significantly lower lapse rate values in the NUCAPS data than the models; a line of showers and thunderstorms were present along this path of lower values...NUCAPS retrievals certainly would have been affected by this area of denser clouds and precipitation. ...lapse rates would be affected (lowered) by the convection in those locations, ...depicted in the NUCAPS data only. So, the lack of this feature in the models would then affect their forecast in this region going forward. ...imagine a scenario where this convection had dissipated and left behind a boundary or gradient in temperature/moisture. The detection of these types of boundaries, that often occur in pulse type convective events especially, can be important for predicting where convection will take place subsequently. ~HWT Forecaster 2019



See the HWT blog for more examples: <https://blog.nssl.noaa.gov/ewp/tag/ncaps/>
<http://goesrhw.blogspot.com/search/label/NUCAPS>

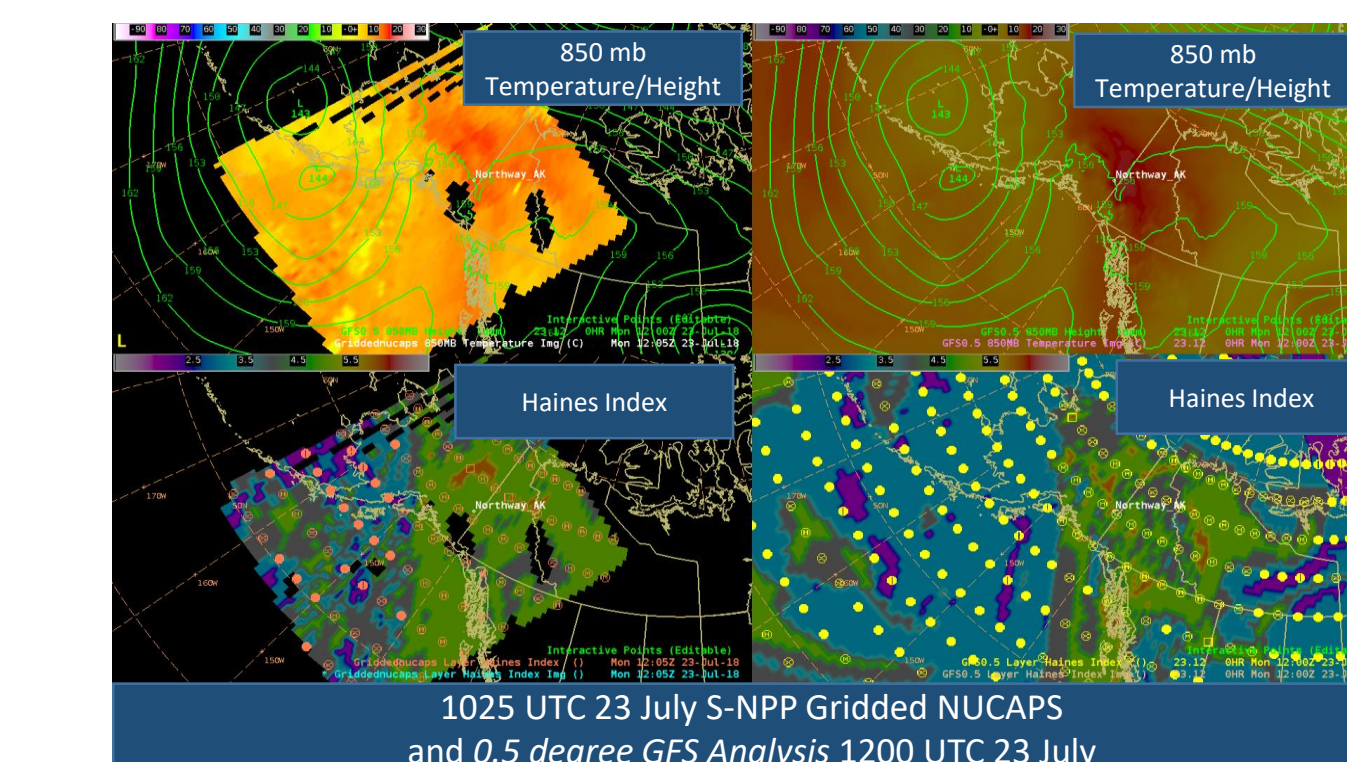
As an operational forecaster, I like to compare model output, real-time obs, and any additional derived data. This image from the NUCAPES H85-H5 Lapse Rate can potentially help boost one's confidence in particular synoptic situations. For example, suppose you were expecting a dryline to emerge east across W Texas, but guidance indicated otherwise and sfc METARS were unavailable, using the NUCAPS Lapse Rate products can help determine the location of the dryline (for this particular setup). In this image, values reflect the drier air advancing east leading to steeper lapse rates. ~ HWT Forecaster 2019



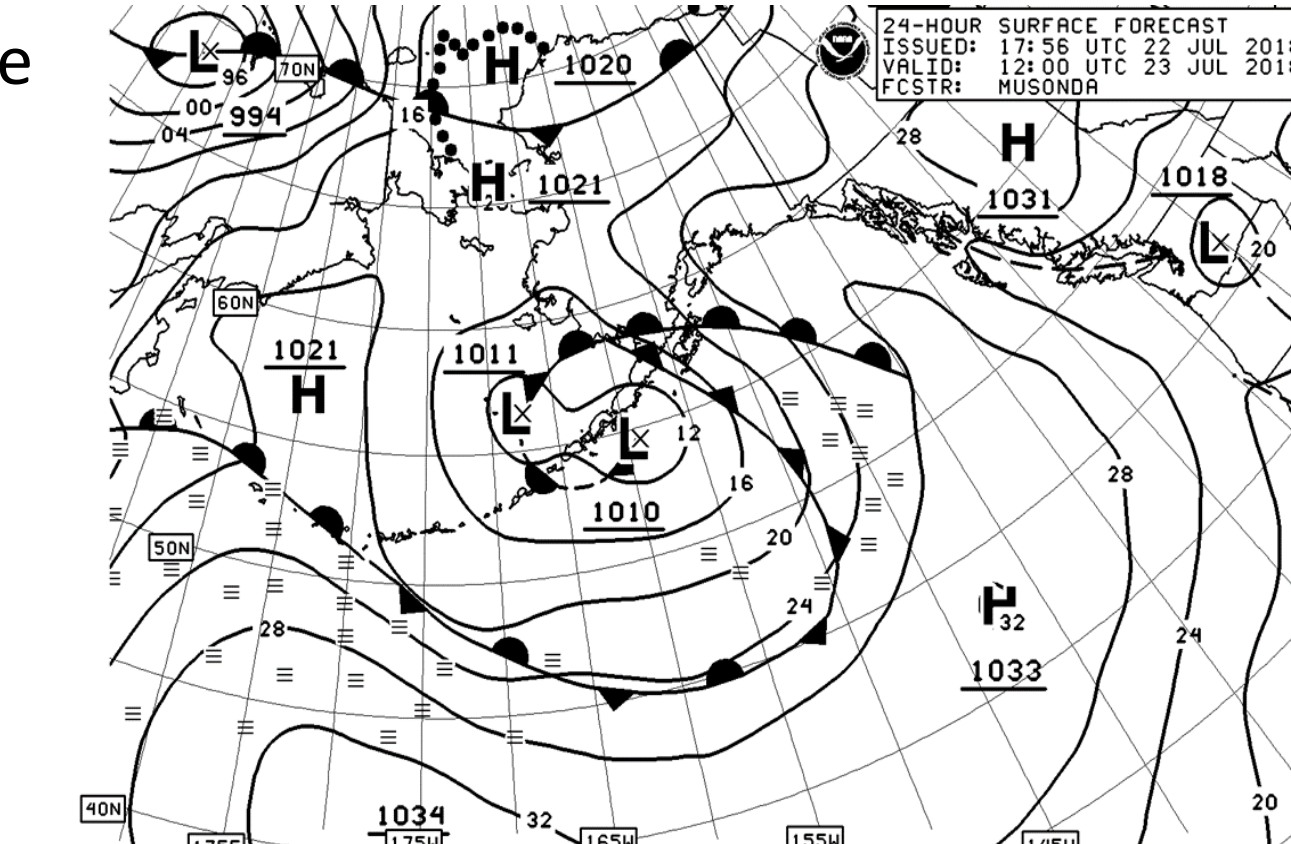
IR and RGB imagery showing outflow coming out of the storms in the eastern LSX area not firing up additional storms. NUCAPS 400-200 mb RH product shows quite a bit of drier air that the line is pushing into. More moisture is west of the MO/IL line, so that part of the line may have a better chance to maintain themselves/develop new cores ahead of the line along that outflow. ~ HWT Forecaster 2019

Fire Weather

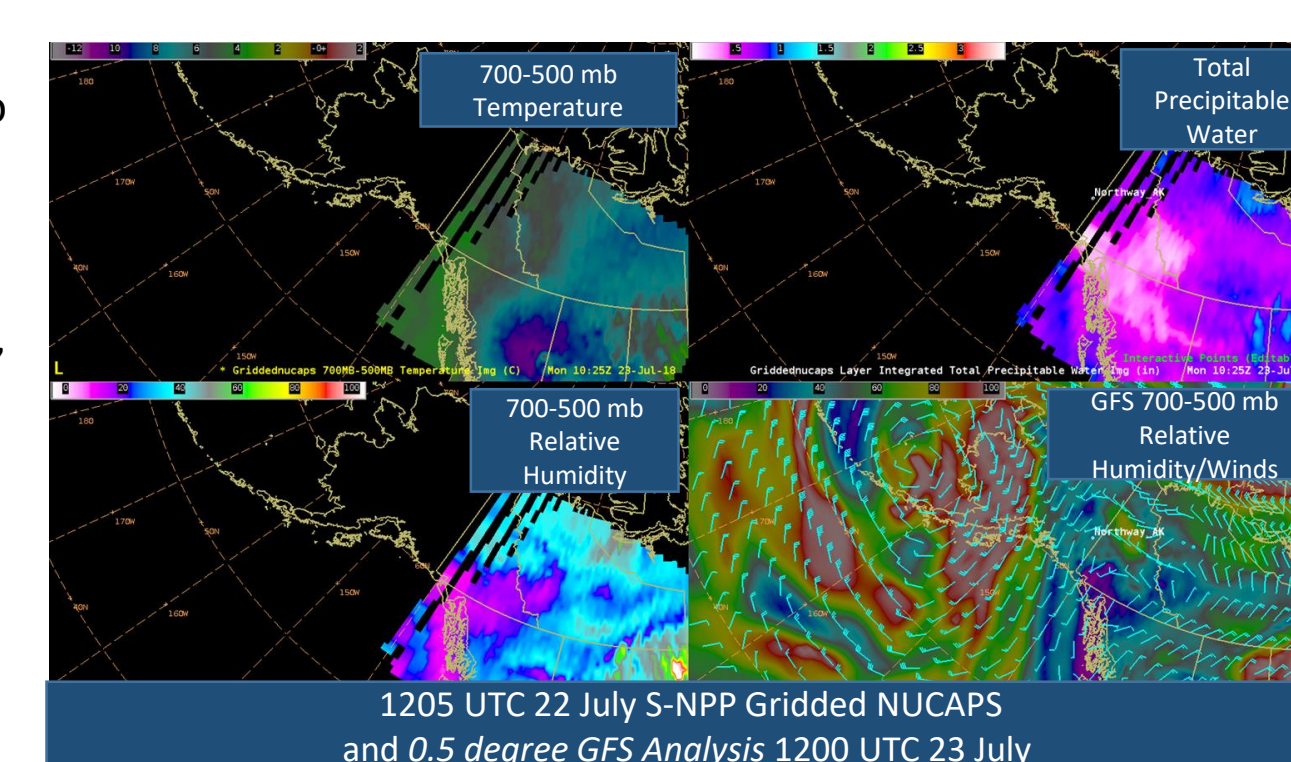
- Analyzing thermodynamic conditions are important for assessing the pre-fire environment and fire potential
- Low-level thermal ridges (LTR's) have been documented as an important influence on wildfire development in the southern Great Plains (Lindley et al. 2017)
- Lindley et al. 2017 studied 11 Great Plains fire events from 2006 – 2014, resulting in representative soundings / thermodynamic fields indicating fire potential
- In contrast, Alaska Region forecasters assess fire potential by analyzing thermodynamic fields for warm, dry conditions and descending motion
- The Haines Index is frequently used to determine the potential for large fire growth (Werth and Ochoa 1993)



- Gridded NUCAPS 850 mb and 700-500 mb temperatures compared to GFS, indicate a region of higher temperatures in southern AK
- The Haines Index indicates a moderate potential for fire growth, matching GFS
- Lower precipitable water values were present over southern Alaska
- Compared to the GFS analysis, Gridded NUCAPS captured the spatial gradients in 700-500 mb relative humidity.



- Taiktsalda Hill near Northway, AK: July 23, 2018
- The fire started on 23 July 2018 near the town of Northway, AK
- The fire continued through 4 August 2018
- Warm, dry conditions persisted as south/southwesterly flow prevailed



Future Applications

- Planned assessments with NWS forecasters to test the utility of NUCAPS for Fire Weather and Turbulence
- Investigation of Microwave-only soundings for applications in cloudy regions such as Icing and Winter Weather
- Determine the value of NUCAPS cloud information for applications that rely on diagnosing cloud properties
- Contact Emily Berndt (emily.b.berndt@nasa.gov) if interested in evaluating Gridded NUCAPS for new applications

Weaver, G. M., and coauthors, 2019: Addressing the cold air aloft aviation challenge with satellite sounding observations. J. Operational Meteor., 7 (10), 138-152, doi: <https://doi.org/10.15191/jnoam.2019.0710>

Aerospace America Feature Article "Danger In the Air" <https://aerospaceamerica.aiaa.org/features/danger-in-the-air/>